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(54) Reference data coding in solid state image sensors

(57) Data is encoded in a solid state image sensor by varying the colour processing (i.e. the colour filter mosaic and/or microlens array) applied to at least some of the border pixels (20) of the sensor pixel array (10). Data may be encoded in the colour processing by varying the pattern of the colour filter mosaic and/or the microlenses in accordance with a predetermined scheme; e.g. by the omission of colour filter material and/or microlenses from selected pixels. The data (typically encoded in binary format) may be read by illuminating the pixel array and processing the output signals from the border pixels. The encoded data may comprise or include colour process codes and/or mask revision codes and/or product codes.

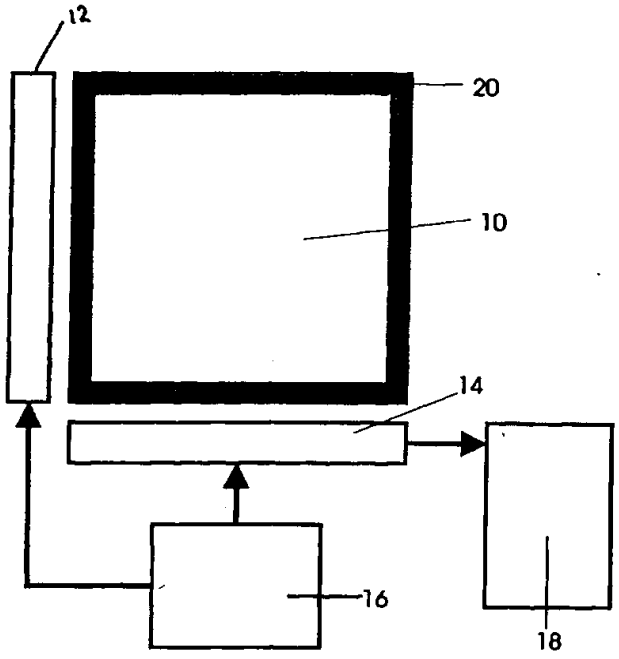

FIG. 1

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Description

[0001] The present invention relates to encoding reference data in solid state image sensors. More particularly, the invention relates to encoding data in the colour processing applied to border pixels of the imaging array of a colour image sensor. The invention may be employed to encode any type of reference data, but is particularly useful for recording colour process and mask revision codes.

[0002] It is well known to record reference data on a variety of types of microchip, including solid state image sensors, during manufacture of the chips. Such data may include product codes and the like, and may be encoded in the chip circuitry using a variety of coding schemes. In the case of an image sensor, such reference data may for example identify the particular type of the basic sensor chip. However, the same basic chip may provide the basis for a variety of different image sensors which differ in terms of the "colour processing" applied to the basic chip. The details of the colour processing determine the characteristics of, for example, the colour filter mosaic and microlens array applied to the chip. It is not practical to record such data in the chip circuitry during manufacture of the basic chip since the details of the subsequent colour processing may not be known at the time of basic chip manufacture.

[0003] Solid state image sensors generally comprise an array of light sensitive elements ("pixels") arranged in rows and columns, together with associated circuitry for reading out signals from the pixel array. All of the pixels of the array are connected to the associated circuitry and are capable of being "read", but a number (typically two to eight) of the rows and columns of pixels around the periphery of the pixel array are not actually used in the image signals output from the sensor. These unused pixels are commonly referred to as "border pixels".

[0004] The invention, in its various aspects, is defined in the Claims appended hereto.

[0005] Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 is a schematic block diagram illustrating a generic solid state image sensor or image sensing system; and

Fig. 2 is a diagram illustrating an embodiment of a data coding scheme in accordance with the present invention.

[0006] Referring now to the drawings, Fig. 1 shows a generic solid state image sensor/sensing system comprising: a sensor array 10 comprising an array of photosensitive pixels arranged in lines and columns; vertical and horizontal shift registers 12 and 14, used for reading output signals from the sensor array 10; control means 16 for controlling the operation of the shift registers 12, 14; and signal processing means 18 for processing image signals from the array 10, which are output via the horizontal shift register 14. The arrangement of the sensor as described thus far is generic for a variety of conventional image sensors and will not be described in detail. It will be understood that the control means 16 and signal processing means 18 may be implemented in hardware, firmware or software and may be integrated on-chip with the sensor array 10, or located off-chip, locally or remotely, or combinations thereof. Generally speaking, the input to the signal processing means 18 will be analog, and the signal processing means may include analog-digital-conversion means, digital signal processing means for a performing any of a variety of signal processing functions as are well known in the art, and storage means for storing one or more images and/or portions of images for a variety of purposes.

[0007] As is well known in the art, the pixels of a number of rows and columns around the periphery of the pixel array 10, typically two to eight rows/columns, are designated as "border pixels", indicated by reference numeral 20 in Fig. 1. The border pixels are fully functional pixels but, in normal use of the sensor, they are either not read or their output signals are ignored; i. e. their outputs do not form part of the image signal produced by the sensor.

[0008] It is known to encode data, such as product codes, in the electronic circuitry of the basic sensor chip during manufacture thereof.

[0009] As is also well known in the art, a colour image sensor is produced by applying "colour processing" to a basic sensor chip of the type described above. Typically, colour processing involves the application of a colour filter mosaic to the pixel array 10. Colour processing may also include the application of a microlens array on top of the colour filter mosaic, to improve the light gathering capacity of the pixels.

[0010] The colour filter mosaic may have any of a variety of well known configurations, using a variety of different colour combinations, typically three primary colours such as red, green and blue or complementary colours such as cyan, magenta and yellow, in order to produce a full colour image output from the sensor. One example of a colour filter pattern is the well known "Bayer Pattern", in which the pixels of the basic array 10 are grouped in blocks of four, with the pixels at two diagonally opposite corners of each block being coloured green and the remaining two pixels being coloured red and blue respectively.

[0011] It is common for a number of different colour processes having different parameters to be applied to basic sensor chips of the same type. It is also common for different versions ("revisions") of a colour process mask to be employed. It is useful for the sensor to have information recorded thereon regarding the colour process applied and/or mask revision employed on that particular sensor. It is not practical to encode such data in

the circuitry of the basic chip during manufacture thereof.

[0012] In accordance with the present invention, data is encoded in the colour processing applied to at least some of the border pixels of the basic sensor chip, such that the recorded data may be read during manufacture of the sensor, subsequent assembly of an imaging system employing the sensor, or subsequent use of the sensor.

[0013] Fig. 2 illustrates a preferred example of a data encoding scheme in accordance with the invention. At 30 there are shown two adjacent blocks of four pixels of a standard Bayer pattern colour filter mosaic, with each block including two green pixels, G, a red pixel, R, and a blue pixel, B, as described above. Binary data can be encoded in the colour filter mosaic applied to the border pixels as logic zeroes and ones as shown at 32A and 32B, 34A and 34B, and 36A and 36B respectively.

[0014] In this example, a logical 0 is encoded at 32A by omitting the red colour filter element from right hand block and a logical 1 is encoded at 32B by omitting the red colour filter element from the left hand block. When the sensor is illuminated by incident light and signals are read out from the relevant pixels, it is possible to discriminate between a signal from a pixel having a colour filter element and a pixel with no colour filter element. The manner in which such signals may be discriminated is well known in the art (e.g. from error detection algorithms used in conventional image sensors) and will not be described in detail herein.

[0015] It will be understood that binary data may be encoded in the colour processing by varying the colour processing applied to individual border pixels in any way which may be discriminated when signals are read out from the pixels. This may be done by omission of any one colour element or combinations of colour elements. Alternatively, instead of omitting a colour element, multiple colours may be applied to the same pixel, making the filter element substantially or completely opaque.

[0016] 34A/B shows a logic 0 and logic 1 encoded by omission of green filter elements, whilst 36A/B shows a logic 0 and logic 1 encoded by omission of blue filter elements. Red, green and blue coding of the type illustrated may be combined in the same colour filter mosaic.

[0017] Alternatively or in addition to encoding data in the colour filter mosaic pattern, data may be encoded in the microlens array applied to the sensor. This is illustrated at 38A and 38B, where a logic 0 is encoded by omitting microlenses 40 from the left hand block of pixels and a logic 1 is encoded by omitting microlenses 40 from the right hand block of pixels.

[0018] Any type of data may be encoded using the method of the present invention. However, the invention is particularly intended for encoding colour process information and/or mask revision information, preferably in combination with a product code. The relevant information requires a relatively small number of bits. An example is illustrated at 42 in Fig. 2, where the data comprises a start code of 4 bits (one "nibble"), a product code comprising three nibbles (3 x 4 bits), a colour process code of four bits, a mask revision code of four bits and an end code of 4 bits. This data is easily accommodated in the number of border pixels available in a typical image sensor.

[0019] It will be understood that the coding scheme employed may vary from the illustrated examples and may be adapted for use with any type of colour filter mosaic or microlens array.

[0020] The data encoded in the colour processing may be read at any time during the life of the sensor by illuminating the sensor and interpreting the output from the border pixels. Algorithms for reading the data may be incorporated in the sensor or sensor system or may be provided separately from the sensor/system. Preferably, the sensor or system circuitry is provided with storage means for electronically storing the data read from the border pixels so that the data is available for use by signal processing algorithms during subsequent use of the image sensor/system.

[0021] Improvements and modifications may be incorporated without departing from the scope of the invention.

Claims

1. A method of encoding data in a solid state image sensor, said sensor comprising an array of pixels including a plurality of border pixels with colour processing applied to said array of pixels, the method comprising varying the colour processing applied to at least some of said border pixels in accordance with a predetermined scheme such that data is encoded in the colour processing applied to said border pixels.

2. A method as claimed in claim 1, wherein the colour processing includes the application of a colour filter mosaic to said array of pixels and said data is encoded by means of varying the pattern of colour filter material applied to said border pixels.

3. A method as claimed in claim 2, wherein said data is encoded by the omission of colour filter material from selected border pixels.

4. A method as claimed in claim 2, wherein said data is encoded by the application of multiple colour filter layers to selected border pixels.

5. A method as claimed in any one of claims 2 to 4, wherein said colour filter mosaic comprises a Bayer pattern mosaic and wherein one bit of binary data is encoded in two adjacent blocks of four pixels of said pattern by varying the colour filter material applied to one pixel of one of said two adjacent blocks.

6. A method as claimed in claim 1, wherein the colour processing includes the application of a microlens array to said array of pixels and said data is encoded by means of varying the pattern of microlenses applied to said border pixels.

7. A method according to any preceding claim, wherein the encoded data includes a colour process code.

8. A method according to any preceding claim wherein the encoded data includes a mask revision code.

9. A method according to any preceding claim, wherein the encoded data includes a product code.

10. A method according to any preceding claim, wherein the encoded data includes at least one of a start code and an end code.

11. A method of reading data encoded using the method of any one of claims 1 to 10, comprising illuminating the image sensor and interpreting signals output from said border pixels.

12. A method as claimed in claim 11, further including a step of electronically storing said data in said image sensor or in an image sensor system incorporating said image sensor.

13. A solid state image sensor comprising an array of pixels including a plurality of border pixels with colour processing applied to said array of pixels, said image sensor including data encoded in the colour processing applied to at least some of said border pixels.

14. An image sensor as claimed in claim 13, wherein said data is encoded by means of a method as claimed in any one of claims 1 to 10.

15. An image sensor as claimed in claim 13 or claim 14, or an image sensor system incorporating said image sensor, adapted to read said data encoded in said colour processing when the image sensor is illuminated.

16. An image sensor or an image sensor system as claimed in claim 15, including storage means for electronically storing said data.

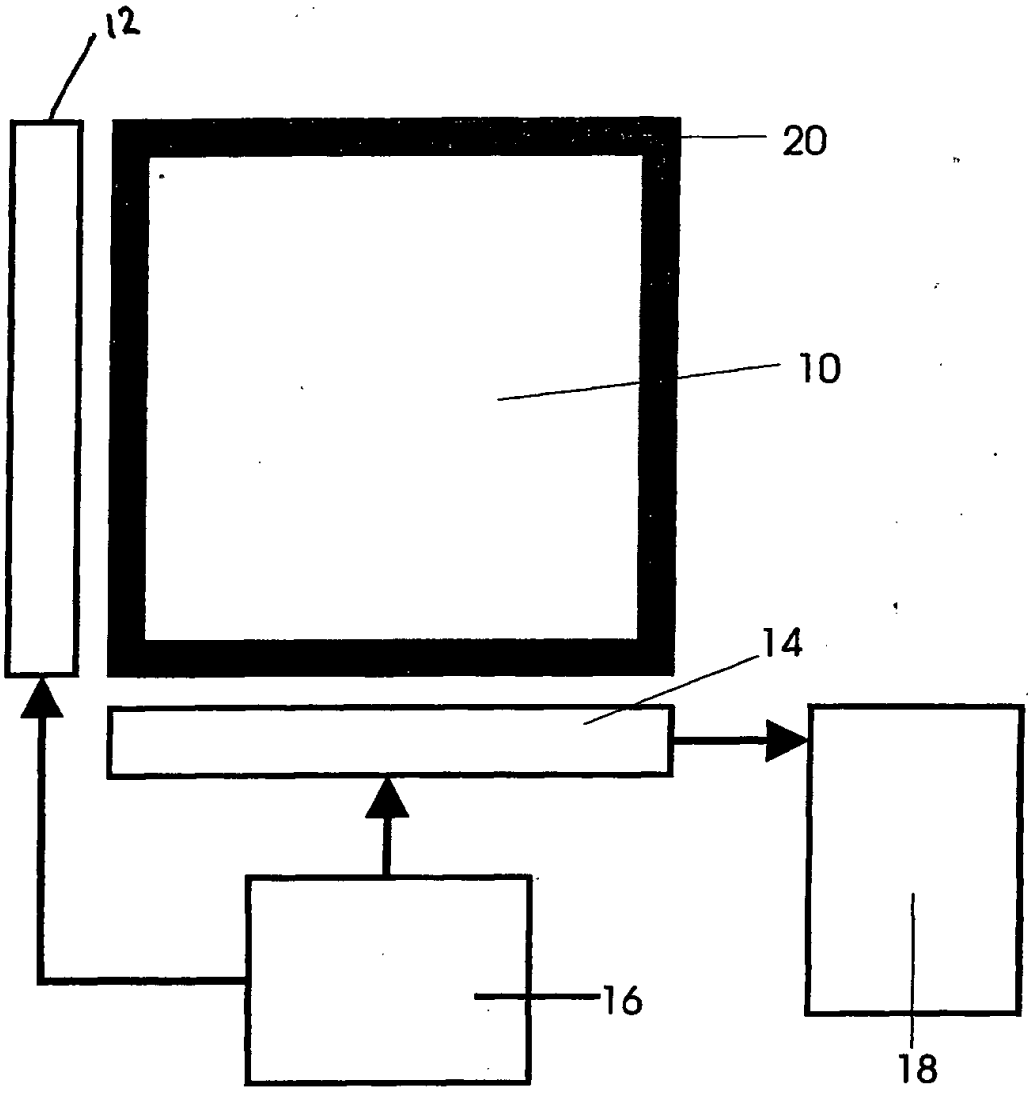
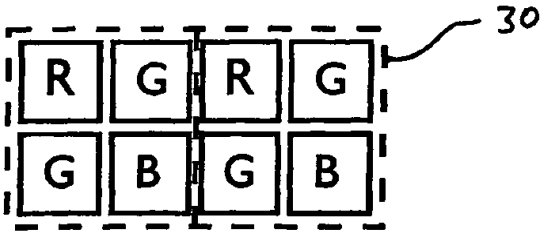
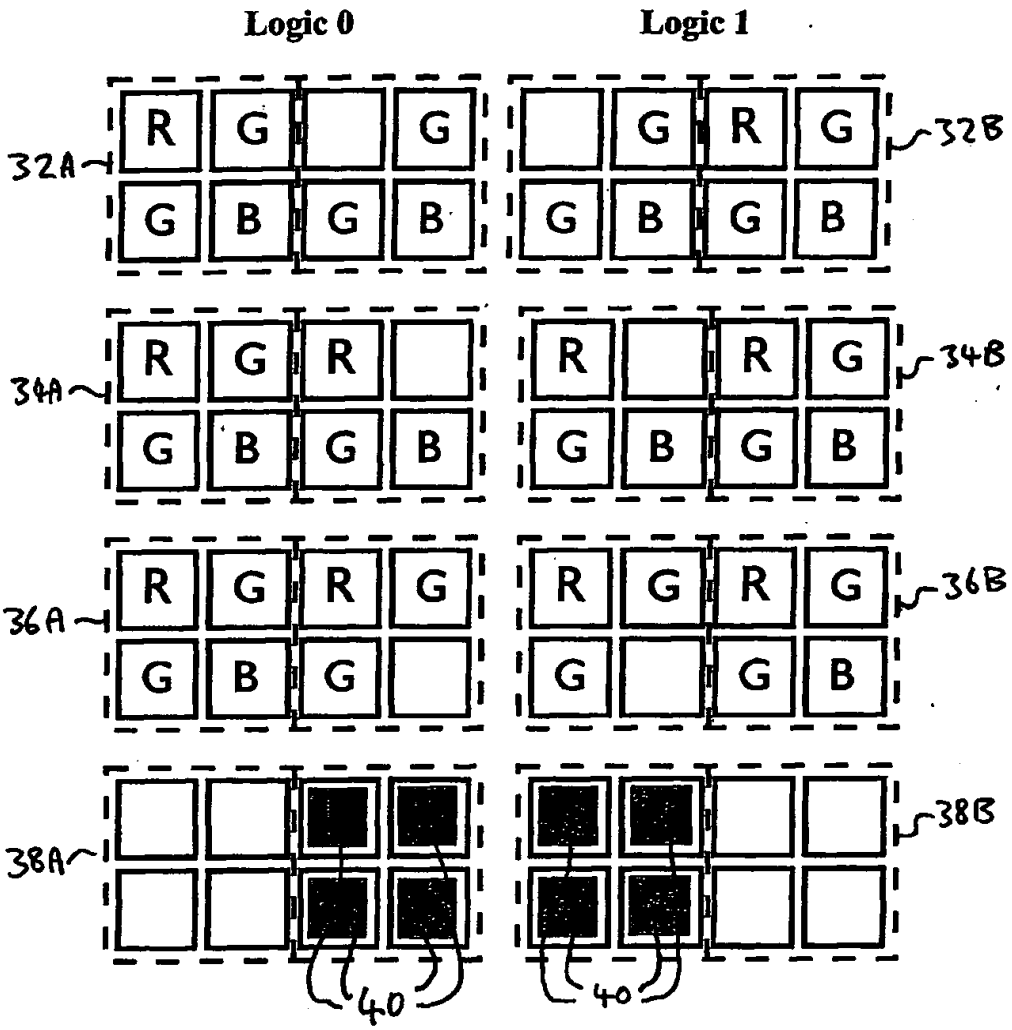
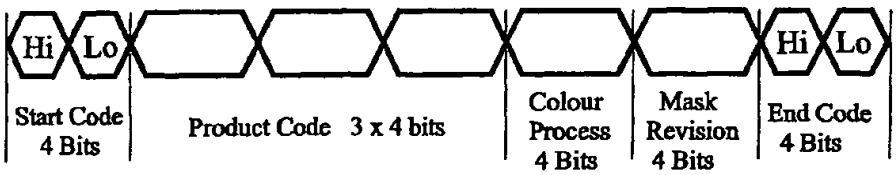


FIG. 1

FIG. 2


30
R G R G
G B G B


Logic 0
Logic 1
32A
32B
34A
34B
36A
36B
38A
38B
40
40


Hi
Lo
Start Code 4 Bits
Product Code 3 x 4 bits
Colour Process 4 Bits
Mask Revision 4 Bits
Hi
Lo
End Code 4 Bits

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EUROPEAN SEARCH REPORT

Application Number
EP 01 30 1123

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	17 July 2001	Visscher, E

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EUROPEAN SEARCH REPORT

Application Number
EP 01 30 1123

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	17 July 2001	Visscher, E

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